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NEAR-REALTIME DATA COLLECTION FROM SYOWA STATION AND ITS UTILIZATION FOR SPACE WEATHER FORECAST (EXTENDED ABSTRACT)

Munetoshi TOKUMARU[1], Kazuyoshi KAWASAKI[2], Masaki EJIRI[3], Hisao YAMAGISHI[3] and Natsuo SATO[3]

[1] *Wakkanai Radio Observatory, Communications Research Laboratory, 3-20, Midori 2-chome, Wakkanai 097*
[2] *Hiraiso Solar Terrestrial Research Center, Communications Research Laboratory, 3601, Isozaki-cho, Nakaminato 311-12*
[3] *National Institute of Polar Research, 9-10, Kaga 1-chome, Itabashi-ku, Tokyo 173*

Abstract: The acquisition and transfer system of observational data of Syowa Station using INMARSAT link have been developed. Using this system, near-realtime data of Antarctica become available in Japan. To apply these data to the space weather forecast, J-index is introduced for a realtime evaluation of geomagnetic activities, which showed a good correlation with the K-indices.

1. Introduction

In 1989, the INMARSAT Ship Earth Station System (SESS) has been established in Syowa Station, Antarctica, to relay the telemetry data of EXOS-D satellite. This link also allows us to transmit observational data of Syowa Station to Japan rapidly. Such (near-)realtime data of Syowa Station is of great interest not only for researchers, who intend to perform a quick survey of the polar phenomena, but also for forecasters who issue alerts and predictions of magnetospheric disturbances (MARUBASHI, 1989). Therefore, we have developed the acquisition and transfer system of observational data at Syowa Station using INMARSAT link. In the present paper, we describe an outline of this system, and the utilization of the transferred data for the space weather forecast.

To issue an alert of disturbances from the collected geomagnetic data, we need to scale the magnitude of disturbance accurately and quickly. The K-index is a well-estabilshed measure of the geomagnetic activity, and the automatic K-scaling methods with digitized geomagnetic data have been studied by several authors (VAN WIJK and NAGTEGAAL, 1977; HOPGOOD, 1986; WILSON, 1987; KADOKURA, 1988). However, the K-index cannot be real-time in nature because one must wait at least until the end of a given 3-hour interval to determine its K-index. Furthermore, longer time span would be required to estimate quiet-day curves from the geomagnetic records.

For the purpose of the real-time evaluation of geomagnetic activities, JOSELYN (1970) has proposed a new geomagnetic index J. The algorithm of J-index has advantages for the use in the space weather forecast; it is objective, does not depend on a quiet day curve, and is applicable to real-time programming, *etc.* Up to now, the J-index has been applied only for geomagnetic data from Boulder, Colorado, and comparative studies of J's at different locations are required. Hence, we perform the J-index analysis for the geomagnetic data from Syowa Station to compare with the results of Boulder.

2. Data Acquisition and Transfer System

Figure 1 illustrates the acquisition and transfer system for observational data from Syowa Station. The data of three-component magnetometer and riometer at Syowa Station are digitized by a personal computer (PC9801) with a sampling period of 1 min and 12 bit resolution. The clock for data sampling is automatically calibrated at 20 UT by a signal from the frequency standard. The digital records of 24 hours are stored in a file of floppy disk, and then transferred regularly to the mainframe computer (M260H) of the National Institute of Polar Research (NIPR) via the INMARSAT link. The time necessary to transmit 24-hour records (1 min sampling) is nominally about 2 minutes. The regular operation started in March, 1989, and it has been working quite continuously; the missing records are only for 5 days in 2 years.

These observational data of Syowa Station are easily accessible not only from each terminals/workstations of NIPR but also from a remote terminal (PC9801) in the Hiraiso Solar Terrestrial Research Center of the Communications Research Laboratory (CRL/Hiraiso), which is a forecasting center for the space environment. The remote terminal is connected with M260H via telephone line with 2400 bps, and the error-free modem with MNP class 5 protocol are employed to avoid errors in the data communication. To perform detailed studies from the viewpoint of the space weather forecast such as the J-index analysis (see the next section), the data are down-loaded to the floppy disk of the remote terminal, and then stored in the memory of the computer system (MicroVAX3500) in CRL/Hiraiso. The

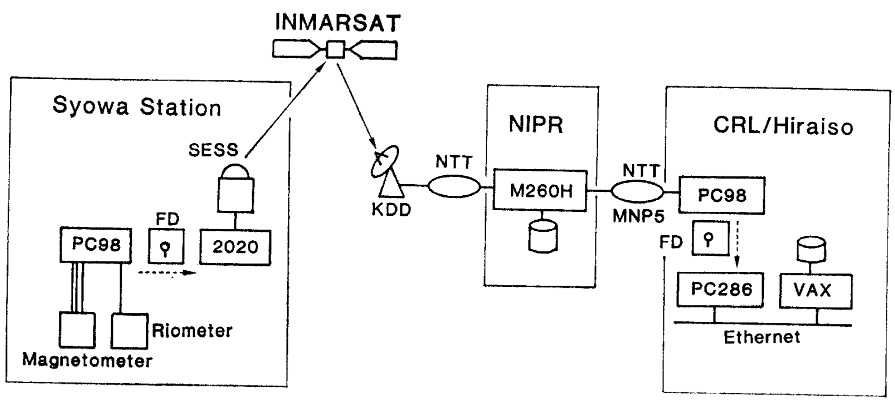


Fig. 1. Outline of the acquisition and transfer system for observational data of Syowa Station using INMARSAT link. The data include the H,D,Z components of geomagnetic field and the cosmic noise absorptions.

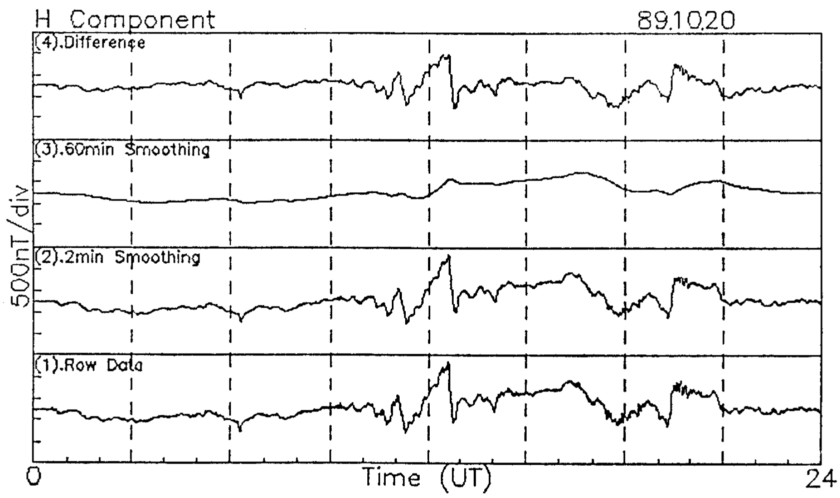
MicroVAX3500 system is a core of the computer network system for the space weather forecast, which is called SERDIN (TOKUMARU *et al.*, 1990), and on-line users on MicroVAX3500 system can easily compare these Antarctic data with the other kinds of realtime or near-realtime observational data collected by SERDIN.

3. *J*-index Analysis

The realtime geomagnetic index J is defined as

$$J = \log\,(\mathrm{d}S_{\mathrm{rms}}) \tag{1}$$

(a)



(b)

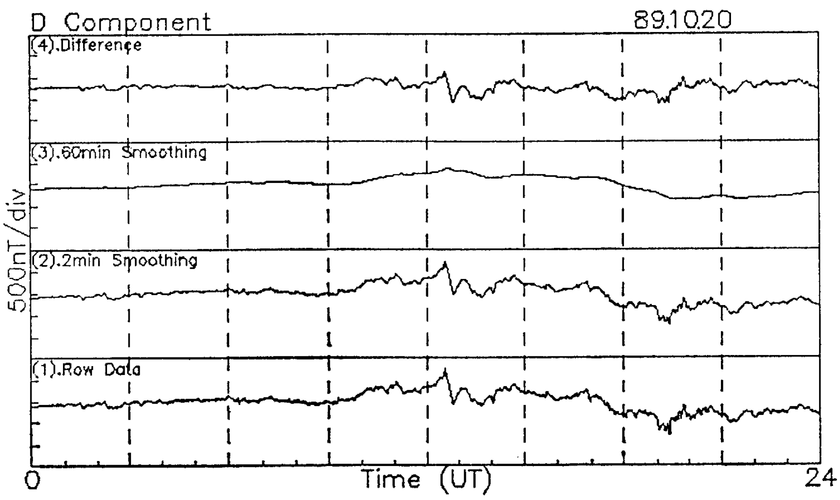


Fig. 2. (a) Horizontal and (b) D components of the geomagnetic field at Syowa Station on October 20, 1989, illustration of the method used in computing J-indices. The lower curves, (1) in the figures indicate the raw (un-smoothed) data. The middle two curves, (2) and (3) indicate smoothed data with time constants of 2 min and 60 min, respectively. The top curves, (4) is the difference between (2) and (3).

where dS_{rms} is the three-hour standard deviation of the difference between slightly smoothed (2 minute time constant) and highly smoothed (60 minute time constant) traces for either H or D components of the geomagnetic field. In the present study, we have performed the J-index analysis for geomagnetic data of Syowa Station in September and October, 1989, and obtained 488 three-hour values (see Figs. 2(a) and (b)). Here, we use a larger value of J-indices obtained from H and D components in a given three-hour period to compare with K-indices.

In Figs. 3(a) and (b), J-indices derived here are plotted against K-indices of Syowa Station and K_p-indices, respectively. The broken lines in each figures indicate the least square fits, corresponding to $J=0.46+0.29\,K$ ($\chi^2=0.034$) and $J=0.57+0.26\,K_p$ ($\chi^2=0.098$) for Figs. 3(a) and (b), respectively. Both plots exhibit a good linear correlation, suggesting that K-indices, even K_p-indices, are well approximated by the J-indices. These results are in general agreement with the previous work of JOSELYN (1970) for Boulder's data, while the distribution of J versus K obtained here exhibits a smaller dispersion than that of the previous results. This

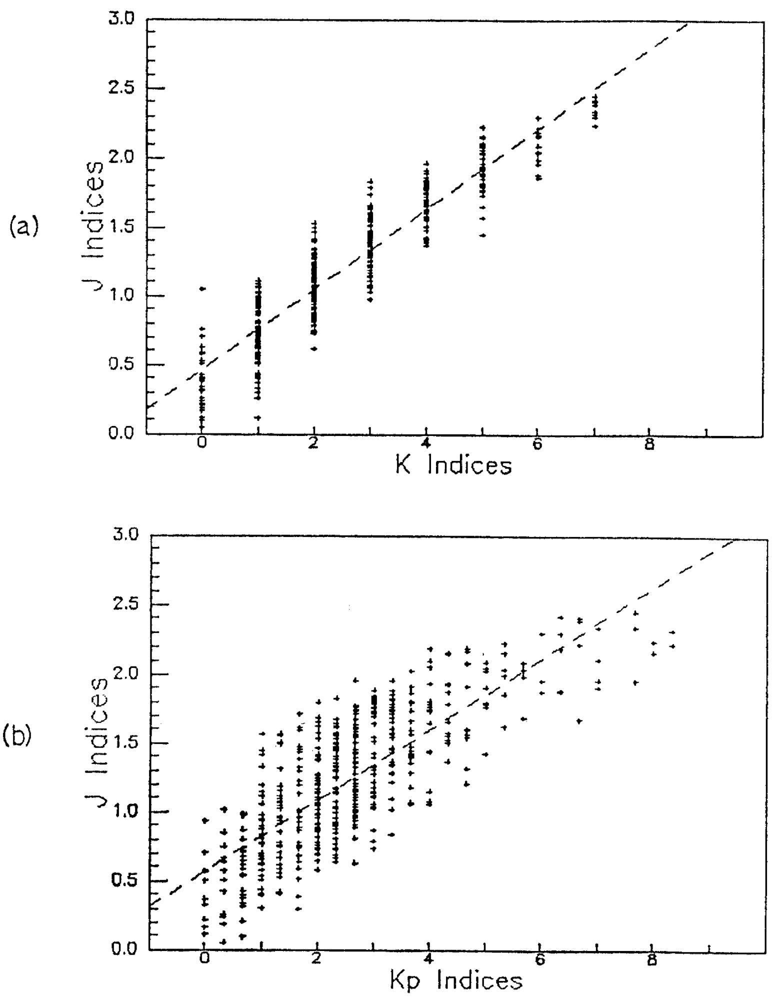


Fig. 3. The J-indices derived from Syowa data in September and October, 1989 versus (a) local K-indices and (b) K_p-indices. 488 three-hour values are included in each figures. The dashed lines correspond to the least square fits.

difference might be partly due to the difference in sampled periods between two studies, and partly due to that of the geomagnetic variations between high and middle latitudes.

4. Summary

We have developed the acquisition and transfer system of ground-based observation data (geomagnetic fields and cosmic noise absorptions) at Syowa Station by the INMARSAT link. This system enables us to utilize Antarctic data in near-realtime in Japan. In connection with the space weather forecast, we have performed the J-index analysis for these data. The derived J-indices exhibit an excellent correlation with K-indices, which is generally consistent with the result of J-index analysis for Boulder data. The results obtained here will serve as a fundamental data to discuss on the planetary J-index, which is to be derived from local J-indices of the world-wide magnetic observatory network including Syowa Station.

The data acquisition and transfer system have been working almost continuously for these two years, however, some problems are pointed out through the actual operations. The most serious problem is that the data transfer is not fully automatic but dependent on teh manual operations, resulting in a heavy load to the operators and a delay time of a few days to transmit the data. A more extensive use of the computer network techniques is required for further applications.

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